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(71) Applicant *(for all designated States except US)*: **COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION** [AU/AU]; Limestone Avenue, Campbell, ACT 2612 (AU).

(72) Inventors; and
(75) Inventors/Applicants *(for US only)*: **COVEY, Geoffrey, Harold** [AU/AU]; 11 Marlow Place, Eltham, VIC 3095 (AU). **RAVERTY, Warwick, Douglas** [AU/AU]; 8 Bannockburn Road, View Bank, VIC 3084 (AU).

(74) Agent: **ALLENS ARTHUR ROBINSON PATENT & TRADE MARKS ATTORNEYS**; Stock Exchange Centre, 530 Collins Street, Melbourne, VIC 3000 (AU).

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: METHOD FOR MAKING PAPER

(57) Abstract: A method for forming a patterned sheet on a paper machine comprising the steps of, a) adding patterning material in a controlled or semi-controlled manner to the upper surface of a cellulosic fibre web sheet at different points during its passage through the paper machine, and b) drying the cellulosic fibre web sheet.

Method for making paper

Field of the invention

The invention relates to a method of producing sheets having patterned effects.

Background of the invention

In this specification, where a document, act or item of knowledge is referred to or discussed, this reference or discussion is not an admission that the document, act or item of knowledge or any combination thereof was at the priority date:

(i) part of common general knowledge; or

(ii) known to be relevant to an attempt to solve any problem with which this specification is concerned.

While the present invention will be describe with reference to the production of sheets of paper, such as paper in the form of sheets of cellulosic fibre web having patterned effects it will be appreciated that the invention is not so limited but also relates to the production of patterned sheets of other material, such as polymer, plastic, metal or laminate.

Paper can be formed in two basic ways, both of which have a number of variants.

The first way of making paper, specifically hand made paper usually commences with the formation of a very dilute slurry or suspension of fibres in a vat. Some of this slurry or suspension is then drained through a mesh or filtration means which is supported by a peripheral frame (the mesh or filtration means together with the peripheral frame is commonly called a deckle mould) so as to produce a web of fibres which can be pressed and dried to produce a sheet of paper. Most commonly, the fibres are cellulosic fibres derived from wood or non-woody plant species.

Various means are known for producing patterned effects in or on such sheets.

One method for achieving a patterned effect is to produce a watermark by including a pattern element on the mesh or filtration means or by impressing a patterned element onto the web prior to or during pressing. This approach is limited in its effect to producing regions of different transparency and the result is normally only clearly visible when an observer views the watermark using light transmitted from behind the sheet.

Another method is to have two or more vats containing fibre slurries or suspensions of fibres of different colours, lengths and/or textures and to blank off different portions of the deckle mould prior to processing slurry or suspension from different vats. A sheet produced in this way has regions of different colour or texture. The method is very time consuming.

Still another method is to include small quantities of additives in the slurry or suspension. The additives are usually in the form of elements which are large relative to the size of the fibres. A sheet formed from such a slurry or suspension will have an internal texture of randomly arranged features. This technique is commonly used by hobbyist papermakers and by some makers of specialty decorative papers. There is very limited scope to control the technique, and the sheet produced has the elements usually arranged substantially at random both over the plane of the sheet and through its thickness.

The second way of making paper is by means of a paper machine. In this method a slurry or suspension of fibres is more or less continuously spread over a continuously moving mesh or filtration means, the web of fibres so formed passing over a series of devices for removing water, for pressing or compacting the web and for drying to form the sheet of paper. This method has the advantages of economically producing paper in large quantities and can be worked with more concentrated slurries or suspensions of fibres than are practical with the hand made method. However, paper making by means of a paper machine is not well adapted to producing patterned effects. The only such effects that are commonly produced on a paper machine are watermarks and additive inclusions.

Object of the invention

It is an object of the present invention to provide an alternative means of producing patterned sheets of paper, plastic, metal or laminate.

Summary of the invention

According to one form of the invention there is provided a method for forming a patterned sheet comprising the steps of

a) adding patterning material in a controlled or semi-controlled manner to the upper surface of a sheet,

b) optionally pressing the sheet, and

c) drying the sheet

Preferably, but not essentially, step (a) precedes step (b).

According to another form of the invention there is provided a patterned sheet produced by the method.

According to a preferred embodiment of the invention a web of cellulosic fibre is used to produce a sheet of patterned paper. Specifically, a web of cellulosic fibre is produced on a paper machine by known means and then, before the web is pressed or dried, patterning material comprising a slurry or suspension of patterning elements, including fibre and/or a pigment is applied at least once to the web. Under these circumstances any fibre or element of high aspect ratio in said patterning material will tend to bond with or become entangled in the fibres in the web and the resulting sheet of paper will bear a pattern. Further if the said application includes pigment, this will tend to penetrate the web.

According to another preferred form of the invention, a sheet of non-woven fabric is produced by known means and then patterning material is applied at least once to the sheet. Under these circumstances any fibre in said patterning material will tend to bond with the sheet. Further if the said application includes pigment, this may tend to penetrate the sheet.

According to another preferred form of the invention, a sheet of metal film is produced by known means and then one or more applications of patterning material is made to the sheet. Under these circumstances any fibre in said patterning material may tend to bond or chemically react with the sheet. Further if the said application includes pigment or reactive materials, these may tend to colour and/or patinate the sheet..

According to another preferred form of the invention, a laminated sheet is produced by known means and then one or more applications of patterning material is made to the sheet. Under these circumstances any fibre in said patterning material will tend to bond with the sheet. Further if the said application includes pigment, this may tend to penetrate the sheet.

The word 'pigment' and forms of the word 'pigment' as used in this description refers to any coloured material suitable for the invention herein described, and includes but is not limited to dyes and slurries or suspensions of solid colourant material.

The word 'pattern' and forms of the word 'pattern' as used in this description refers to any differentiable feature which can be distinguished from other areas of the sheet whether that distinguishing feature displays a repeating form or not.

The sheet produced by means of this invention can be used for any suitable purpose. For example, the sheet of paper may be decorative (such as wall coverings) structural (such as for

use in architectural screens) or for security purposes (to produce a distinctive sheet which is difficult to copy), or it may perform some combination of these functions.

Description of the method

The invention will now be further explained by reference to some specific means of performing the method.

The examples given here are generally directed to machine made sheets of paper but, as will be apparent to one skilled in the art, most of the methods are equally applicable to sheets of non-woven fabric, metal film or laminate any of which may incorporate additional surface coatings that enhance the bonding of the patterning material.

Typically, the pattern is not distributed right across the width of the sheet. Therefore in a preferred embodiment the patterning material will be applied to the sheet or web of cellulosic fibres comprising the sheet by means of one or more conduits that deliver the patterning material to only a portion of the width of the sheet.

The sheet may be moving relative to the conduits. The delivery ends of the conduits may be adapted so that the force of impact of the patterning material onto the sheet is controlled to obtain a desired effect. Further, the orientation and open area of the ends of the conduits may be varied so that the velocity of the emerging stream of patterning material relative to that of the sheet can be adjusted.

In a further embodiment, the conduit is adapted so that its delivery end is capable of being moved in a direction substantially parallel to the plane of the sheet and perpendicular to the direction of movement of the sheet. This arrangement will permit the position at which the patterning material is applied to change relative to the edge of the paper. This movement can be caused by mechanical or manual means.

In an alternative embodiment, multiple conduits with fixed delivery ends are provided and the flow of patterning material through each delivery end is capable of being controlled. Typically, the conduits may be individually controlled. In this way a pattern can be produced by a process analogous to that employed by an ink-jet printer.

In a still further embodiment, multiple conduits having delivery ends are provided and at least some of the delivery ends are capable of being moved in a direction substantially parallel to the plane of the web and perpendicular to the direction of movement of the web. This enables comparatively complex patterns to be produced without requiring an excessive number of

conduits. The movement of the conduits may be individually controlled or controlled in groups.

In another preferred embodiment, a number of different patterning materials are provided to one or more conduits such that only one patterning material is supplied at a time, or different combinations of patterning materials are supplied at different times. By use of this arrangement it would be possible to make, for example, a pattern consisting of a stripe on the sheet which changes in colour along the direction of movement of the paper machine.

It will be apparent that all or most of these facilities can be combined. However it may be inconveniently complicated or expensive to provide all of the effects simultaneously.

It will be noted that the way in which these patterns are applied can be changed to suit the particular purpose for which the sheet of paper produced is to be used. For example, if a paper sheet is to be used for producing secure documents, then the pattern will preferably be repeated over a short distance (for example every 50-250 mm). Alternatively, if paper is to be used as wall paper or for some analogous purpose, then it might be desired for the pattern to repeat over a relatively long distance (for example every 2-4 m) or be non-repeating. If the paper is to be used for an artistic display, then it may be preferred that there is no repetition of the pattern, in which case the pattern could be randomly generated (e.g. by use of a computer) or the pattern could be manually generated by the direct intervention of the user of the invention.

The patterning material can be one or more of various different types of material, depending on the effect that is desired.

Typically the patterning material is a colouring substance such as dye, pigment or a formulation including one of these or a texture creating substance such as a fibrous, granular or pulpy material. In the particular case of a paper sheet, by introducing the colouring substance whilst the sheet or web is still wet, the colouring substance will tend to penetrate the sheet and cause colouring through part or all of the depth. This may even occur with sheets which resist the penetration of inks when they have been dried. Therefore this effect may be useful in making papers for both decorative and security purposes.

Where the patterning material is cellulosic fibre pulp it may be introduced together with a colouring agent. The pulp may be introduced in small quantities so as to produce a different colour or texture over part of the surface of the sheet. In this case the pulp may be introduced as a slurry or suspension of similar fibre content to that normally used in paper making.

Alternatively, the pulp may be introduced in larger quantities so as to produce relief effects. In latter case it may be found advantageous to introduce the pulp at somewhat higher fibre content and/or with longer fibre lengths than is usually used in paper making.

The patterning material may be applied in any convenient form such as a liquid, slurry or suspension or solid. For example, in the case of a paper sheet where the patterning material is slurry or suspension it may contain at least one solid material other than normal papermaking fibres. Examples of such materials include:

- Very long fibres and/or plant fragments so as to produce effects similar to those in some traditional Japanese papers. Such papers show a pattern in transmitted light and are useful for making paper screens for use in windows or room dividers.
- Materials which give texture or optical effects such as granular or reflective material.
- Security features, such as fibres which can only be distinguished by illumination with ultra-violet or infra-red light or other non-visible electromagnetic radiation. If these are placed predominantly at surface regions, then in addition to their normal function, their absence in some areas would indicate that information has been erased from the sheet.

It will be apparent that multiple additions of patterning material may be made to produce particular effects.

When the patterning material includes fibre or other solid, it may be useful to include a binding agent such as an adhesive to improve bonding between the patterning agent and the sheet.

When the invention is used for manufacture of patterned sheets on a paper machine, the patterning material may be applied to the fibre web at different points during its passage through the paper machine depending on the effect required.

Typically the patterning material will be applied in the forming region of the paper machine onto a formed fibre web, for example just after the point where the sheet is 'set'. If a patterning material containing solids is added in this region there will be comparatively little intermingling of the solids of the sheet and the patterning agent, but good bonding between the patterning material and the fibre web may be achieved.

For some purposes preferably the patterning material is applied to the web of fibres in the region prior to where the web is fully formed or set. In this case there may be some intermingling of the patterning material and the fibres from which the sheet is formed in the upper portion of the web. This embodiment is particularly useful when the patterning material includes very long fibres and/or plant fragments as such patterning material cannot be conveniently processed in a conventional paper machine.

When making relief or textured effects, it may be desirable to press the sheet prior to adding some or all of the patterning materials. This reduces the subsequent need for drying and gives a stronger base sheet.

The word 'comprising' and forms of the word 'comprising' as used in this description does not limit the invention claimed to exclude any variants or additions.

Modifications and improvements to the invention will be readily apparent to those skilled in the art. Such modifications and improvements are intended to be within the scope of this invention.

The claims defining the invention are as follows:

1. A method for forming a patterned sheet comprising the steps of

(a) adding patterning material in a controlled or semi-controlled manner to the upper surface of a sheet,

(b) drying the sheet.

2. A method according to claim 1 which additionally includes the step of pressing the sheet prior to step (b).

3. A method according to claim 1 wherein the sheet comprises material chosen from the group comprising paper including a web of cellulosic fibres, polymer fibres,, metal or laminate.

4. A method according to claim 1 wherein the components of the patterning material are chosen from the group comprising a colouring substance, a binding agent, a texture creating substance or a combination thereof.

5. A method according to claim 1 wherein the patterning material includes components chosen from the group comprising very long fibres, fibres distinguishable by illumination, plant fragments, materials capable of imparting optical effects or combinations thereof.

6. A method according to claim 1 wherein the form of the patterning material applied to the upper surface of the sheet is chosen from the group comprising solutions, semi-solids, emulsions, slurries, suspensions, solids or combinations thereof.

7. A method according to claim 1 wherein the patterning material includes fibre and the fibre bonds with the upper surface of the sheet.

8. A method according to claim 1 wherein the patterning material includes pigment and the pigment penetrates the sheet.

9. A method according to claim 1 wherein the patterning material is applied to a portion of the upper surface of the sheet.

10. A method according to claim 1 wherein the force of impact of the patterning material onto the upper surface of the sheet is controlled to obtain a desired effect.

11. A method according to claim 1 wherein the patterning material is applied to the upper surface of the sheet in small quantities such that the patterning material provides colour or texture over part of the surface of the sheet.

12. A method according to claim 1 wherein the patterning material is applied to the upper surface of the sheet in large quantities such that the patterning material provides relief effects.

13. A method according to claim 1 wherein the patterning material is applied to the upper surface of the sheet by means of one or more conduits each conduit having a delivery end which in use is adjacent the sheet.

14. A method according to claim 13 wherein the orientation and open area of the delivery end may be varied so that the velocity of the emerging stream of patterning material can be adjusted.

15. A method according to claim 13 wherein the one or more conduits are adapted so that the delivery ends are capable of being moved in a direction substantially parallel to the plane of the sheet.

16. A method according to any one of claims 13 to 15 wherein the one or more conduits and the sheet are independently moveable and the one or more conduits are moved perpendicular to the direction of movement of the sheet such that the position at which the patterning material is applied can be changed relative to the edge of the paper.

17. A method according to any one of claims 13 to 16 wherein the flow of patterning material through individual conduits or groups of conduits can be independently controlled.

18. A method according to any one of claims 13 to 17 wherein the orientation of individual conduits or groups of conduits can be independently controlled.

19. A method according to any one of claims 13 to 18 wherein a first patterning material is applied through a first conduit or group of conduits and a second patterning material is applied through a second conduit or group of conduits and wherein the first patterning material is applied simultaneously with the second patterning material.

20. A method according to claims 18 or 19 wherein the second patterning material is applied subsequent to the first patterning material.

21. A method for forming a patterned sheet on a paper machine comprising the steps of,

(a) adding patterning material in a controlled or semi-controlled matter to the upper surface of a cellullosic fibre web sheet at different points during its passage through the paper machine, and

(b) drying the cellullosic fibre web sheet.

22. A method according to claim 18 wherein the patterning material is applied in the forming region of the paper machine onto the formed cellullosic fibre web sheet.

23. A method according to claim 18 wherein the patterning material is applied to the cellulosic fibre web sheet in the region prior to where the cellulosic fibre web sheet is fully formed or set.

24. A method according to any one of claims 19 to 23 wherein the sheet is pressed prior to adding some or all of the patterning agents.

25. A method according to any one of claims 19 to 24 wherein the sheet is pressed subsequent to adding some or all of the patterning agents.

26. A patterned sheet produced by the method of any one of the previous claims.

27. A patterned sheet according to claim 23 wherein the patterned sheet is suitable for a purpose chosen from the group comprising decorative, structural or security purposes or combinations thereof.

28. A patterned sheet according to claim 7 wherein the pattern is repetitive.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01268

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: D21H 23/28, 21/40, 19/66, 27/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: D21H and pattern, reinforc, dry and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 580363 A (THE WIGGINS TEAPE GROUP LIMITED) 26 January 1994 Claims	21,24-27
X	US 4239591 A (BLAKE) 16 December 1980 Claims	21,24-27
X	WO 99/22068 A (ARJO WIGGINS FINE PAPERS LIMITED) 6 May 1999 Abstract	21,24-27

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17 October 2002	22 OCT 2002
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **M. BREMERS** Telephone No : (02) 6283 2052

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01268

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5897746 A (ATTENBURGER et al.) 27 April 1999 Claims	21,24-27
X	Derwent Abstract Accession No. 2001-384813/41 classes F09, G02 JP 2001115393 A (OKURASHO INSATSU KYOKUCHO) 24 April 2001 Abstract	21,24-27
X	Derwent Abstract Accession No. 2000-287077/25 class F09 JP 2000080597 A (OKURASHO INSATSU KYOKUCHO) 21 March 2000 Abstract	21,24-27
X	Derwent Abstract Accession No. 86-115661/18 class F09 JP 61055285 A (KASHIKI SEISHI KK) 19 March 1986 Abstract	21,24-27
X	Derwent Abstract Accession No. 92-296011/36 class F09 JP 04202898 A (FUKUI KEN) 23 July 1992 Abstract	21,24-27

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU02/01268

Box I **Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos :

because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos : **1-20, 22, 23 and 28**

because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

Claims 1-20, 22, 23 and 28 are so broad that no meaningful search was possible on these claims. The only preferred embodiment described is that which corresponds to claim 21. Therefore this search has been restricted to claims 21 and 24-27.

3. ☐ Claims Nos :

because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

Box II **Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU02/01268

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
EP	580363	BR	9302956	CA	2100914	FI	933289
		JP	6108399				
US	4239591	NONE					
WO	9922068	AU	94534/98	BR	9814095	CA	2304300
		EP	1025311	US	6319360		
US	5897746	DE	4344552	FI	946060	EP	659935
JP	2001115393	NONE					
JP	2000080597	NONE					
JP	61055285	NONE					
JP	4202898	NONE					

END OF ANNEX